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ABSTRACT

This paper deals with methods and models appropriate to the systematic linguistic study of the child's acquisiton of phonology. Sections I through IV present a review of previous studies in the field, discuss the usefulness of the concept of "innateness," discriminate between phonetic and phonological ability, and discuss the concept of discrete units in language and its relationship to language learning. Section V then presents a "Preliminary Outline of Phonology Acquisition" based on the theory that the acquisiton of phonology involves a large number of interrelated stages which cannot be strictly isolated from one another. The idea of a "prelinguistic" stage is rejected, it being assumed that the child's linguistic development begins soon after birth. The child's development through the babbling stage and his acquisition of the concepts of sentence, syllable, segment and distinctive feature are then traced. Because the syllable is considered the first elementary unit of a child's speech and therefore of importance as the source of other units, the lengthy final section of the paper is devoted to the acquistion of syllable structure. (FWB)

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THE ACQUISITION OF PHONOLOGY

Arlene I. Moskowitz

I. Introduction

Until quite recently, the child's acquisition of language has not been the object of serious and systematic linguistic study. This neglect has been unfortunate; in addition to being of interest purely in itself, the study of language acquisition may lend insights into the organization of linguistic information in the human brain. The data which can be offered for such study is different in many significant ways from that which linguists dealt with, in general, until recently; and we are only now beginning to recognize the possibility that such inquiry can be carried out, and to develop appropriate methods and models.

During much of the nineteenth and twentieth centuries it was believed that phonology acquisition was a haphazard process, varying greatly from child to child. This belief was probably both cause and effect of the many diary studies produced in that period. The wealth of material in those diaries, written by men of varying competence without benefit of tape recorders, indicated that segments[1] were not acquired in an order which could be established as essentially invariant across children or languages. Prior to 1941 no goal other than the ordering of acquisition of segments was conceived for acquisition studies.

It took the genius of Roman Jakobson to produce order from this chaos which others had viewed as hopeless. After reading much of the available diary material, Jakobson compiled his abstractions and impressions into a monograph entitled Child Language, Aphasia, and Phonological Universals, which drew together facts and hypotheses from other aspects

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1. Throughout this paper the term 'segment' will be used to indicate a phoneme or phone or other unit of approximately the same length.

of phonological study. The major thesis of the monograph is that the three fields specified in the title are interrelated, and in fact the correlations are quite specific: there is inherent in phonology a natural hierarchical ordering, and this same hierarchy is reflected in all three studies. Acquisition commences with that which is highest in the hierarchy and progresses systematically through it to its culmination with the lowest relevant steps; aphasia begins with the loss of those lowest steps, and proceeds through a mirror image of the acquisition sequence; that which is acquired first and lost last is also the most universal among languages of the world. A completely specified hierarchy is not offered (it was obviously Jakobson's intention to be sufficiently vague) but a long list of sub-relationships is given, with extensive examples, (E.g., a language can utilize fricative consonants phonemically only if it also utilizes stop consonants; a child substitutes for those fricatives he has not yet acquired the stops of corresponding place of articulation; frontal articulation precedes back place of articulation for a series of sounds with like manner of articulation; therefore, before a child can acquire--or a language can have--a back fricative, a preceding front fricative and a back stop are essential.) One of the more significant aspects of Jakonson's contribution, in addition to his discovery of the patterning in the acquisition process, is the example he has set for us by his willingness to look at new aspects of the situation: where there was not a pattern to be found in an ordering of segments, he found a pattern in the ordering of distinctive features.

The four major points which Jakobson has made are summarized by Charles A. Ferguson as follows:

1. At any given synchronic stage during the process of language acquisition, the child's speech has a structure of its own.
2. In addition to this central systematic, structural core of speech there are some marginal (extra-systematic) elements.

3. At any given stage, the child's speech will exhibit systematic correspondences to the adult model.

4. Across all children and all languages, there is a regular order in the acquisition of phonological distinctions.

These four points, which had to be made before any progress could occur in the study of acquisition, taken together with the specific proposals for the ordering mentioned in point (4), form a significant motivational base on which most subsequent research could have been built. It is probably fair to say that one of Jakobson's main concerns was the repudiation of the observations of haphazardness so that linguists could move in the direction of developing a theory of phonology acquisition. Although the book is crammed with the exciting insights of its author's genius, the richness and variety of its unexplored and suggestive comments do not constitute a theory and are obviously not intended to do so, but instead constitute the evidence that it would be possible and productive for an extensive theory to be developed.

Most of the material published since Jakobson's book has missed the point entirely. There have been several new diary studies, all of which improve upon those of the pre-Jakobsonian era by the greater sophistocation of their phonetic data, and all of which support point (4) in its prediction of regularity, although usually with the qualification that their data seems to contradict one or more of Jakobson's more specific porposals about that ordering. A handful of them evidence point (3), and (2) remains somewhat ignored as linguists ignore extra-systematicity so as to devote themselves to the consumate discovery of systematicity.[2]

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2. It would be more accurate to say, instead, that the extra-systematicities of child language are rarely so daring and exceptional that their marginality forces notice; instead they are often sufficiently like the system that it is easy not to recognize their true nature but instead encompass them in the system. Apparently, recent diary writers not only didn't question their lack of evidence for point (2) but instead gloried in the absolute regularity they had 'discovered.'

The four points were not stab-in-the-dark hypotheses, and did not need this elaborate documentation which has distracted us from the business at hand, namely, the need to discover what it is that the child learns and how he learns it. That there is a regular order in the acquisition of phonological distinctions is, to Jakobson, a property of language --that is precisely why he can associate it with a reverse ordering in aphasic loss and with a hierarchic ordering of universal phonomena-- and not a property specifically of language learning. Therefore, all evidence we can gather from children about the exact properties and optionalities of this ordering will contribute to general phonological theory, and so are of interest. But such evidence offers no contribution to our knowledge of the essential nature of the language acquisition process, tells us nothing about how the child copes with the proliferating data from his environment, and noes not even acknowledge, let alone elucidate, the kinds of conceptual discoveries the child must make during the acquisition of a sound system in order to develop an adequate linguistic framework for the phonological system which structures the phonetic output.

Almost 30 years ago, Roman Jakobson laid the groundwork for an exciting new discipline within linguistics by showing us the raw data were manageable. Since then linguists have expended considerable energy repeating the message, but have made little progress in listening to, understanding and implementing it.

II. The Direction of Investigation

2.1 In all future investigation in phonology acquisition, we must bear in mind the necessity of the openess which Jakobson exhibited. Viewing the data of child speech through the distortions of a current theory of phonology may be very obscuring, while allowing the data to reveal its own systematicity may provide the insights for correcting

some of those distortions and thus for improving the theory. Jakobson's prediction that the child's phonology exhibits structure at any given stage is deliberately non-commital about what that structure in fact is. The successive phonological distinctions he discusses are in effect an outline of a diachronic acquisition process, while that process' implications for a view of snychronic structure are considerably more limited. Thus the longitudinal data for a particular child may provide evidence that the distinctions X, Y, and Z have been acquired (and are therefore latent to the system--may be drawn upon for future use) while an analysis of the synchronic stage immediately following may not involve X, Y, and Z as functional aspects of the system of produced phonology.* What that synchronic system is must be revealed exclusively by the data itself.

2.2 A second point we should keep in mind when determining new directions for acquisition theory is that the notion of 'innateness' is actually a very weak one. Anytime we must explain some aspect of the acquisition by pronouncing it 'innate' not only have we said nothing relevant about it, but also we have obscured the possibility of a more insightful explanation by hiding the necessity for explanation under a satisfactory-sounding label. The most interesting questions about the learning process are utterly destroyed when we assume that innateness replaces the necessity for learning. (Even if it were to turn out some day to be true--although such a possibility is quite improbable--that, for example, the concept of rule structure within phonology is innate in the human mind, our investigations of how it could be learned if not innate, our conjectures about what types of phonological information are prerequisite to the formation of such a concept, and our resultant deeper understanding of the functions of rule structure within the child's growing linguistic capacity will all remain valuable insights into the nature of language and the psychology of language use.) By properly

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*I think that Jakobson has unfortunately been misinterpreted on this point by many who have followed him.

identifying that which is innate we will be better able to isolate the kinds of concepts the human mind must employ in dealing with linguistic data as well as the nature of the processing such data must undergo. And the essence of a theory of phonology acquisition does not deal with the order of emergence of specific surface phenomena (although that is interesting in its implications) but deals instead with the learning of concepts and the process by which the linguistic environment is organized into a coherent and logical world.

In coming to understand precisely what is innate to the process of language acquisition, we must be willing to begin to take very seriously the requirements which an innate structure must meet. To say that the child is born equipped with an LAD is to paraphrase the fact that the human being is somehow predisposed to learn language; to say that a structure such as the transformational cycle is innate is to make substantially strong claims about the human brain. This second type of claim is less justifiable given our present knowledge.

2.3 A very important distinction must be made at the outset between the acquisition of phonetic structure and the acquisition of phonological structure. The two processes are quite distinct, and the failure to separate them completely may result in their mutual obscuration. There is some evidence that at the earliest stages of phonology acquisition when the system is still quite primitive, the child's capacity for phonetic production[3] is considerably more advanced than would be indicated by the bulk of his utterances; a few extra-systematic items, either isolated or stable, must not be misinterpreted as indicating a more advanced phonological system despite their phonetic complexity. Likewise, lack of phonetic evidence may not necessarily preclude the possibility of a phonological distinction existing in the speech of an older child. The 'fis' phenomenon is by now a

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3. Phonetic ability or capacity is the extent to which the human child can produce sounds, no matter what the motivation or meaning of the production. In contrast, phonological capacity is delimited by the phonological system being employed.

classic example of just such a situation--the child seems to feel that he is incorporating an s/š distinction which the adult listener cannot hear in the phonetics of the production. A more elaborate example is supplied by the child who produced [ð] only after nasalized segments, and otherwise produced [d] or simply omitted the consonant altogether in situations where the model utterance exhibited /ð/. It is only by means of this very limited phonetic evidence that we can recognize in her speech a phonological distinction between the segments /d/ and /ð/. Suppose our sample had no examples of /ð/ in this peculiar environment, or even that the child did not have this peculiar rule at all but simply used [d] for /ð/ or omitted the consonant: what criteria will serve to distinguish adequately the possibilities of phonological gap and phonetic lack?

2.4 There are many 'little' facts, mysterious observations, unusual and exceptional phenomena which have been noted and are literally floating around in the literature on the acquisition of phonology, ungrounded precisely because there is no way to fit them into present all-encompassing frameworks. We have ignored their implications rather than change the frameworks, in direct contrast to the tradition within linguistics which has always assumed that valuable insights can be achieved by looking at such phenomena--where would Verner be if he had chosen to ignore discrepant data? A theory of phonology acquisition must explain all such data.

III. Phonetic and Phonological Ability

If we compare the sounds of language to building blocks, it is possible to question whether the child begins with one immense block which he cuts into successively smaller pieces or whether he begins with a vast number of tiny blocks and groups them into larger clumps, perhaps tossing some out in the process. In fact, both of these processes

occur. Before the learning of the phonological system commences, the sounds the child hears present a wide phonetic variety--it may even be that two different occurrences of initial /t-/ in the same word are heard as different. The child must learn to erase the tiny phonetic differences in such a case--put the blocks together into the same perceptual pile. Similarly. one of the functions of syllable reduplication in the child's speech [as will be discussed in greater detail later] is to provide the child a framework in which he can compare successive occurrences of the same phonetic unit in order to test the limits of phonetic differentiation which does not cross over the boundary to distinctive differentiation.

At the beginnings of language acquisition, during the babbling stage, the child's phonetic abilities are much greater than they will ever again be. It has been reported that the child produces during this time all possible language sounds. This does not mean that every child produces all possible souns, but rather that each one is capable of doing so, and in fact most children will babble a large number of them. This ability is not lost at the point when the child begins to use words, although some children do cease babbling at that time.

One mother reported to me that her 25-month old son had said 'pencil' perfectly four months earlier on one occasion (his first try) but had since said only [pʰɛ]. Another child's first identification of orange juice was impressive in its exactness, and it was then reduced to [du], where it remained for awhile. Examples such as these indicate that after phonological acquisition has begun, phonetic capacity (as here displayed in an imitation situation) is still quite extensive. It is through the process of phonology acquisition that such ability is diminished.

Simultaneous with the process of building phonetic block-piles is one of breaking down phonological blocks. Suppose the child's system exhibits, for example, several syllables which sound to us as if they utilize the onsets [p-], [t-], and [s-], but no others; the child's vocabulary

will probably contain words which in the adult model begin with /p-/, /t-/, and /s-/, but also with other consonants as well. Thus one (potentially phonological) unit of the child's speech originally corresponds to several in the model but is subsequently broken down.

IV. Discreteness and the Nature of Language

In the area of syntax we have long recognized that the 'value' as it were, of a sentence is greater than the sum of its parts. The way we think about syntax has at its roots our assumption that the discreteness which we can impose upon the units--words, morphemes--in a sentence is only incidental to the more interesting facts we can discern about sentences. In comparison, discreteness has taken on a much more important role in phonology. At the very heart of any phonological discussion lies the tenet--no longer given the lower status of 'assumption'--that speech is composed of discrete segments of phoneme length. Not only do we believe that a linguistic description of speech must recognize such discreteness, but we seem to also believe that speech itself consists of discrete segments.[4] The acoustic evidence may be to the contrary, but that must be explained in some other way.

The child, of course, has a limited amount of data presented to him when he is faced with the task of language learning. He is not endowed with the intellectual capacity to hear speech in the same manner as does a literate adult. He hears only an acoustic signal, and is faced with the task of deciphering it. There is no evidence of segmental discreteness in that acoustic signal, and the imposition of a grid of discreteness is one of the more difficult aspects of language learning; it is not innate, it is not learned very early, and there is still some question about how essential a concept of discreteness is to the learning process at all.

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4. I think that there was a time when the discreteness problem in phonology was emphasized, but the contemporary literature no longer does so.

Although we are constantly reminded that all children learn to speak successfully, we must keep in mind that not all children learn to use language equally well,[5] nor do all people achieve the same level of sophistocation in their ability to manipulate language. Some adults have managed to deduce much abstract information about language purely from the acoustic signal; others can be taught some such abstractions via a process which is perhaps different from that utilized by the first group; still others find it difficult to conceptualize linguistic abstractions at all. Not everyone learns to speak, write, and communicate verbally with equal dexterity. Language is not especially democratic.[6] The assumption that X is innate implies that all speakers should be able to learn X equally well, while lack of such an assumption indicates either (1) that X is so basic to the language that anyone learning to speak the language must learn X to some degree, or (2) that X lies within a domain of abstraction that some speakers achieve. For example, if we assume that the transformational cycle is indeed a part of English phonology then if it were innate, all speakers would know it; otherwise, it might be the case that some speakers have learned it (the transformational cycle being the most efficient way to deal with stress) while others still operate with less sophistocated, less abstract processes for predicting stress.

All children learn to walk; some learn to dance. A few human beings develop sufficient control over the muscles of their bodies to be great ballet artists. Likewise, all humans learn to talk, but for some the learning process ends more quickly than for others. Language is sometimes a rather opaque method of communication between two people.

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5. Note, for example, that very early in the educational process evaluative and intelligence tests heavily utilize verbal skills.

6. For example, Lila Gleitman has shown that different groups of speakers of English may operate with very different rules relating to noun-compounding.

The human child is presented with long sequences of sound--phrases, sentences--and in that acoustic signal there is no obvious segmentation. He is innately endowed with the ability to discriminate those sounds produced by members of his species from all other sounds. He is probably further endowed with something which tells him to find intelligible component parts to something which as a whole is unintelligible--an intellectual concept which is evidenced by many non-language forms of endeavor also. And he will procede from the phonetic, non-discrete nature of language to the highest level of abstraction he can achieve.

V. Preliminary Outline of Phonology Acquisition

Much of the earlier literature makes a distinction between a 'pre-linguistic stage' and a 'linguistic stage', the separation occuring at the point when the child acquires his first word. The evidence for that acquisition may be either the production of that first word, or the contrastive production of the first two words. This distinction between two stages is arbitrarily based on the criterion of the adult's recognition of an overt manifestation which happens to be explainable in terms of sdult speech, and is thus not only not necessarily justifiable in terms of the child's linguistic capacity at any one point but also may be extremely misleading, in that it implies that this is the one major step a child makes in linguistic knowledge. The theory presented here assumes that there are a large number of interrelated stages, representing various degrees of sophistocation, which cannot be strictly isolated from one another in any such neat manner. It also assumes that the child, from fairly soon after birth, begins his linguistic development, and therefore manifests no pre-linguistic stage as such. The pre-verbal stage is very short, and is followed by babbling, the significance of which has just been guessed at prior to this time.

The babbling period begins with the production of short utterances and progresses eventually to include production of quite long utterances which can be characterized as sounding subjectively very much more language-like than their precedessors. Early in this period the child is aware of the difference between human and non-human sounds in his environment, an innate endowment; during the babbling stage he in addition develops a linguistic identity of his own, i.e., the closer he can match his sound productions to his perceptions of human sound, the more he can identify himself as a member of the species community. He is surrounded, moreover, by an incredible diversity of sound, for he is able to hear phonetic distinctions with great accuracy (although there is no reason to assume consistency) but he has no concept of the potentiality of a system underlying that array of sounds--the system is a deduction he will make much later on the basis of his own speech behavior. Therefore those perceptions which his production is compelled to match are pretty random.

The first of the child's endeavors which we notice is the increase in the length of the strings he produces: together with this is an increase in the total amount of verbal output per time segment. The increase in output is probably in part a maturational result and in part a behavioral evidence of the child's increasing awareness that the speech of the adults in his environment consists of longish but finite strings of random sound; the child's earlier short utterances have given him the practice necessary for these longer outputs, which are more rewarding precisely because they more closely approximate what he hears as language, namely long random strings. In other words, within the child's world, he is beginning to satisfactorily participate in the process of linguistic exchange known as communication. This constitutes a first major step in socialization (or the learning of semantics) by its suggestion of a unit which can carry meaning, namely a long finite

string of sound separated by pauses, known as 'sentence'. In fact the sentence in this way becomes the first linguistic unit for the child.

A significant thing which is occurring during this time is the initiation of a process which is described in detail by Braine in "On two types of models of the internalization of grammars". Briefly summarized, this process involves the operation of a series of storage devices within the brain. These storage devices, or black boxes, are ordered with respect to the strength of the learning they represent. All linguistic data enters the first black box, and all data which cannot be shifted fairly soon to the next box is eliminated from the first box by forgetting; data shifted to the second box last a little longer before they must be shifted to the third box--where they will last even longer--or else returned to the first box where they are subject to the same time restrictions as any new data entering that box. In very simplified terms, data is shifted to a higher box when enough instances of a particular type of data are collected in a particular box to warrant such a shift; they are shifted to a lower box if additional occurrences are not found. This model is proposed by Braine to account for grammar learning, but it works just as well for the sound system. The process requires no negative feedback whatsoever (and indeed there is strong evidence that negative feedback about either pronunciation or syntax is not utilized by the child.) It provides us with a picture whose implication is that that which occurs most generally in the input will be sorted out first by the child and will therefore occur first in the output; that which is more limited is a detail which the child can afford to turn his attention to when he has mastered the control of the more general aspects of grammar or phonology.

The manner in which this second process works during the late babbling stage is quite simple. The child is still listening to a vast amount of phonetic input which sounds reasonably random. But the

grossest features of the input--namely the supersegmental features which we call intonation--move rapidly from box to box and are learned before any other aspects of the sound system. We often acknowledge the child's early ability to differentiate the grossest features of intonation when we recognize that very young children can 'tell' our moods from our 'tone of voice'. In conjunction with the increasing length of his babbling utterances, we would expect the child to make use of this new knowledge of intonational structure by imposing a small number of recognized patterns on his babbling utterances to make them sound once more like his perceptions of the utterances of adults--longish strings of random sounds with superimposed intonational structure. There is some evidence that children do exhibit intonation patterns characteristic of the adult language in their late babbling, although the evidence is certainly inconclusive as yet and the matter needs more investigation.

The preoccupation with intonation which the child exhibits in his late babbling stage has distinct ramifications in the subsequent step in phonology acquisition. Before we can examine this we must backtrack slightly to examine two concepts which have developed. The first is the concept of unit, which has so far had its only manifestation (in production) as the sentence-unit. The only relevant phonetic feature of the sentence-unit is the intonation which it carries. We may therefore suspect that when the child begins to look for a unit smaller than the sentence, he will be predisposed toward finding one which is still a carrier of intonation. The second concept as yet exists only in the child's preception; his overt behavioral evidence of this concept is purely non-linguistic. Specifically, he is able to recognize the name of a game (such as 'patty-cake') or other similar label which obviously elicits from him a fixed behavior pattern. He may not be reacting to the exact words <u>in toto</u> which the adults use to label the game, but he can

recognize some part of it (as was true of the child who produced the correct behavioral response which was expected for 'clap hands' when he recognized the word 'hands' embedded in his father's sentence, a sentence addressed to another adult and dealing with a different topic.) Labelled games of this type apparently exist in a large variety of cultures and are usually aimed at the 'pre-verbal' child. When the child is able to react consistently to such a stimulus, we may conclude that he has learned that a particular subsequence of the sentence-unit may have meaning by itself and, in particular, that a linguistic string may have 'meaning'. Whether this represents the acquisition of the concept of 'word' is actually still an open question; certainly this is at least a precursor of that concept, but the amount of generalization necessary from this pattern to the concept of 'word' is significant, and may still be in the future. Unquestionably, however, this step represents the child's new awareness that some of the vast number of phonetic differences in the sounds around him are inconsequential. His tolerance of the small differences in subsequent adult productions of that label indicates that he has made the first giant step in the acquisition of phonetics--the realization that some but not all sound differences are inconsequential, and particularly that certain slight phonetic variations are 'free'. It is probably often true that a game name or other such label will typically be offered to the child in a higher-than-normal pitch or with an exclamation intonation, thus making the child's job of recognition somewhat easier than it might otherwise be. In addition, acquisition is facilitated by the many reproductions of the word or phrase, often in isolation, and by the fact that it is one of the few bits of linguistic input which is directed at the child in particular.

As we have said, this focus on intonation has important ramifications. Again following Braine's model, we see that once the child has

mastered some of the salient aspects of intonation he is free to turn his attention to the phonetic qualities of sentences once again. In grammar acquisition, we see that after the child has gone through a stage of holophrastic sentences, he deduces from the model a particular type of two-word relationship, ignoring all other aspects of word combination. Similarly, during sound acquisition, the child who has operated with a sentence-unit for a while is ready to abstract out of the model a more salient unit: his experience has taught him that a limited number of contrasting sentence-intonations do not suffice to express all possible meanings that this verbal environment seems to offer, and so he knows that he still has a job to do, although he is not aware of the incredible magnitude of the job. There are two significant factors which determine the precise nature of the next linguistic factors he will master: (1) he still can hear a huge variety of phonetic differences, and he has no possible way of sorting out from this mass which differences are inconsequential--indeed he does not yet realize in any pervasive way that most of the differences are inconsequential (and certainly has no suspicion of the variety of ways in which a difference may be inconsequential)--and he has no semantic or syntactic clues which will aid him in developing a relevant discovery procedure; and (2) he has previously worked with only one type of unit, and that unit has significantly been one which carries intonation. Thus his search for a smaller unit than the sentence is, in effect, a narrowing-down process which should produce for the child a unit smaller than the sentence but which can carry intonation; there is absolutely no reason to suspect that the child would be able to achieve the understanding of a unit as small as the segment, and all of the evidence presented so far indicates that this next significant unit is the syllable.

Once this notion of the syllable has been arrived at, further babbling may or may not continue; if it does continue, its function is not entirely clear--it may just be a remnant of 'fun' vocal activity; if it does not continue, it may be that the child has realized the magnitude (partially) of the job before him, and he is embarking on the activity of devoting much of his attention to the solution.

The initial syllables are all CV types; this phenomenon, together with the facts that almost all languages have CV syllables, and that CV syllables are statistically the most prevalent among the different syllables of a given language, are all due to the same cause: that they are phonetically the simplest.[7] (Since we have no evaluative way of defining 'phonetic simplicity' in linguistics, we have avoided using the notion for a long time now, which has actually been a good step in the direction of not over-using and mis-using the notion. We see in child language data, however, a good criterion for defining this notion: however, we again must not over-use the argument, because the facts of phonetic simplicity are interfered with by the concurrent phonological learning.)

The phonetic realizations of these first syllables may be extremely varied, except that they all have features of stress and/or pitch. At about this same time, with the help of both his new-found short unit and the labelling activity of the adults around him, but also

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7. Jakobson ("Why Mama and Papa") speaks of this tendency: "During the babbling period in the infant's development, many of the uttered syllables consist of a vocalic sound succeeded by a consonantal articulation. The most natural order of sound production is an opening of the mouth followed by its closure....As soon as the child moves from his babbling activities to the first acquisition of conventional speech, he at once clings to the model 'consonant plus vowel'. The sounds assume a phonemic value and thus need to be correctly identified by the listener, and since the best graspable clue in discerning consonants is their transition to the following vowels, the sequence 'consonant plus vowel' proves to be the optimal sequence..."

with the aid of other devices which we know nothing about, the child develops the semantic notion of the 'word,' a linguistic concept of great consequence. The word and the unit become equated, and the child's perception of the minor phonetic variations of the words of his environment leads him to the conclusion that a certain amount of phonetic variation is permissible within the definition of a word (syllable) which still retains its identity as opposed to all of the other words of his vocabulary. He may ascribe too much leeway to this phonetic variation, and will have to correct that later through counter-notions of phonetic invariance.

In his early inventory of syllables (which constitutes both the syllabary -- the phonological inventory -- and the lexicon -- the vocabulary inventory) the child will of necessity utilize some distinctions to keep these words apart. They are not always successful distinctions, and the result is that it is often difficult for adults to tell when the 'first words' have been introduced into the child's language. If they are successful, and the child will soon find a way of making them so, they may depend on distinct intonations or may depend on the embodiment of a phonetic distinction which happens to be incorporated phonemically into the adult language, such as pa vs. ka. This second type of distinction will eventually be added, if not immediately, and it is this which is most interesting for our purpose. The child's strategy is quite simply to select and use a variety of different syllables, the repetitions of which enable the practice of two necessary types of learning: by practicing different syllables, the child begins to grasp the notion of phonetic contrast, and particularly consistent contrast: by practicing different repetitions of the same syllable at different times, the child begins to grasp the notion of phonetic similarity and identity, together with the limits of the absolute free variation which is an inherent part of any phonetic series of like phonetic

manifestations. Through the necessary processes which result from the syllable's place as the elementary unit of speech, the child develops notions of rules in phonology, directionality of rules, and elementary phontactics.

Through his practice of syllables, the child develops the specific motor-coordinations and brain directions to the muscles which will be an unconscious part of his language-use for the rest of his life. Through this process he suppresses all those extremely similar but not exactly the same possible sets of neural commands which would produce slightly different acoustic results, and this may be the reason why correct pronunciation in second language learning is so difficult: in fact, it predicts that such learning will be more difficult if it involves neural command patterns which had to be explicitly suppressed, as opposed to those which were irrelevant and therefore neither practiced nor necessarily suppressed. To give a concrete example, suppose that the child incorporates into his syllabary the syllables ka and ki. Let us look closely at what the child both learns and suppresses in the process,

First he learns the correct front vs. back productions of /k/ not as allophonic variants of the same phoneme, but as the distinctly different onsets which these two phones represent before the two different vowels; it will not be until much later that he 'realizes' that these two different [k]'s are variants of the same phoneme, a fact which will come considerably after the understanding of 'complementary distribution.' For now, he is simply learning a set of neural commands which determines the salient features of an entire syllable ka and an entire syllable ki, including the specific changes in formants which determine the connections between k and a, between k and i, as well as the targets for the formants at the onset of the syllable and at its end (the latter also including a portion of time before the end)

and as well as the time relationships which connect these targets in an acceptable pattern. In the process he learns the amount of variation which may be tolerated for the result to be a correct production, and must suppress those configurations which result in productions which are just beyond the limits. He need not suppress those possibilities which are sufficiently beyond the limits to be excluded automatically once the limiting possibilities have been excluded. In addition, he must learn to produce these syllables with aspiration on the initial part, or onset; he learns to produce the 'correct' amount of aspiration by suppressing the slightly different possibilities of too much or too little aspiration, but he does not have to suppress the extremely different possibilities of lack of aspiration or extreme plosion. It is later, when he must learn to control both the unaspirated [k]'s of other syllable positions and the unreleased [k]'s of still others, that he will have to suppress those as possibilities for the allophones of /k/ which occur in the environment V. We would suspect that since he does not ever have to suppress extreme release, he would be able to learn a distinction of /k_1/ with the degree of aspiration acceptable in English vs. /k_2/ with an extreme explosion with reasonable ease in a foreign language. (My own introspection indicates that this is correct.) The presentation of this paragraph is, of course, extremely over-simplified, omitting both detail of the processes mentioned and also additional processes involved in the same picture, but the idea is a significant one: the child learns the constraints on phonetic representation automatically as part of the practice of the syllable acquisition stage, and long before those constraints play any part in the phonological aspect of language. Thus we can conclude that those phonetic details rightly do not belong to the structure of language in any way, and allophonic statements have no place in a linguistic description of phonology.

Inherent in the syllabic function of sound learning are the two opposing and complementary processes of 'grouping' several phonetically similar manifestations into one unit (i.e., building up units by means of losing distinctions) and of 'degrouping' (i.e., extracting out from a vast number of different sounds some distinctions which 'work'). These learned distinctions, we must remember, are at the level of the syllable, the only significant unit the child has so far. All such distinctions, throughout the entire process of acquisition of sound system, will continue to be learned at the level of the syllable. Once the child has begun the process of deducing segments and distinctive features from their syllable context, that process will slowly transfer the function of phonological elementary unit from the syllable to the segment and/or distinctive feature. As the transfer process becomes more rapid, and its results therefore more pervasive, information about distinctions, acquired at the syllable level, is rapidly subject to the transfer process. That the transfer is nevertheless not always rapid will become obvious when we look closely at some relevant data. But first we must examine the origins of the transfer process itself.

We return momentarily to two of Jakobson's four claims, namely that at any stage the child's speech has a structure and that it also embodies some extra-systematic aspects. Until this point in development, we have claimed, the child's system lay in the syllable structure, and the marginality was manifested in those words which had been learned essentially as 'phonetic idioms' (memorizations of the type exemplified by Hildegard's prIti, to be discussed later) with no relationship to the syllabary as the source of phonological units. This extra-systematicity of phonetic idioms will probably continue to be present in the sound system throughout life; but a new and more significant source of marginality is introduced with the transfer process which relocates the elementary unit into the embodiment which is smaller than the

syllable -- once the transfer is partially completed, all the information which remains encoded in syllable form is extra-systematic (and, in fact, constitutes a body of 'phonological idioms'), as is all new information coming into the system until such new information is re-encoded.

We can now view the child who has a reasonably large syllabary and has begun the deductive process of judging some small phonetic differences to be non-distinctive and certain other gross phonetic differences to be distinctive, and we can view him in the light of the acquisition model which we have proposed. As he sorts this data of his syllabary through the black boxes of memory, he slowly but surely discovers the significant generalization of the processes of judgment of phonetic sameness and phonetic difference, that generalization being that the judgment need not be confined to individual syllables. Although on the level of neural and motor control, and thereby production, the exact phonetic qualities of segments are still controlled by earlier syllable learning, on the level of segmental encoding the differences between the several different t's before distinct vowels become insignificant. The child 'realizes' that these are in some sense the same t (because the transfer of the more miniscule phonetic differences to higher boxes has left the lower ones free to deal with these larger differences), and thus the concept of a phonological unit smaller than the syllable is discovered.

At the very beginning of this process, just one or a very few segments are thusly extracted from the data of the syllabary. But there is a chain-reaction through the syllabary which insures that eventually all (or almost all) of it will be reanalyzed this way. Suppose, for example, that consonant X is first discovered as a segment in this manner; that implies that there are in the syllabary several syllables in which consonant X occurs, and the new status of consonant X

leaves all of these syllables in an unusual position, partially devoid of their earlier integrity. The vowels A, B, C, ... of these syllables which involve X as onset will then be subject to immediate reanalysis as segments, too. Those which occur with reasonable frequency in the syllabary will in turn realize this potential reanalysis (while a few may not) and will therefore instigate reanalysis of other consonants, Y, Z, ... with which they occur in syllables. Through this process, then, a large number of segments will eventually be developed as independent units of the phonology.

(It is important to interpose here a brief explanation of the precise meaning of 'segment' in this context. The notion is only vaguely similar to the idea of the taxonomic 'phoneme.' The segment is limited to only one possible position with respect to other consonant or vowel segments and word (syllable) boundaries. In the above example, consonant X is limited to the environment #_V. In other words, the segment is limited to the environment from which it is extracted. In addition, the segment does not necessarily include all of the reflexes of a particular 'phoneme' -- the child might, for example, have two different k segments, for obvious reasons.)

It is now apparent that a child will have a larger repertoire of distinctions among consonants in word-initial position than in word-final position throughout most of the acquisition period precisely because segments first are discovered through their occurrences in CV syllables, and later in CVC syllables -- the chain reaction takes much longer to affect final segments.

One further generalization will eventually occur in this process of extending notions of phonetic sameness and phonetic difference. This last step requires even greater tolerance for phonetic diversity than the previous one, and it is reserved probably for a much later stage since it is not a necessary step in the sense that it is not pre-

requisite for the development of a linguistic concept, nor is it an ordinary step in the series of reanalyses that the child experiences. In fact, it is nothing more than a logical conclusion to the distinctive feature acquisition process which is bound up with the segmental recoding. This generalization is that which identifies some segments as being 'same' and lumps them together, resulting in a limited inventory of segments which is close to, but not isomorphic with, a traditional inventory of taxonomic phonemes. By means of this generalization, the child is able to lump together the contextually-conditioned variants of a segment, such as t-/#_V, -t-/V_V, -t/V_#, and the several segments t which occur in various positions in various clusters. In addition the child is now able to, if he has not already done so, group together 'allophones' which are conditioned by specific and more limited qualities of the context -- an example being k before front vowels, and k before back vowels.

The order in which individual segments are acquired varies greatly from child to child. The order in which distinctive features are acquired, however, is regular, as has already been pointed out by Jakobson; and the expected regularities are precisely those which Jakobson has described as general properties of the nature of language.

Soon after the child begins extracting segments from his syllables, he is in a position to compare these segments and derive from them a still more elementary unit. This unit is the distinctive feature, and its earliest occurrences will be of a general nature, e.g., consonantal vs. vocalic. Later, refinements such as the division of one feature into two -- consonantal vs. non-consonantal and vocalic vs. non-vocalic -- will take place. As these features represent the ultimate units for which the child has been searching, no further learning beyond the refinement of this system itself (except for the insignificant further generalization of segments previously discussed) is predicated upon it.

The child's attention is now focused on discovering the complete system upon which is based the structure of phonology. Schvachkin's experiment with Russian children indicates that there is evidence in perception that this ordering is both neat and explicit. Evidence in production is not nearly so neat, indicating interference from phonetics and possibly also from that property of language which we designate by the term 'marking.'

The interference of phonetics is a two-fold one, and is deeply embedded in the pervasive conflict between phonetics and phonology which the child has spent so much effort resolving. At early stages, phonetic ability is considerably greater than can be displayed through the structural seive of phonology -- thus we often find that the child's very first production of a particular word is phonetically quite accurate, while subsequent productions are mediated by the existent phonology and seem therefore to be phonetically much less sophisticated. (This fact, incidentally, indicates that all child sound system data which have been collected in 'imitation' situations are probably unreliable and even misleading.) At later stages -- when phonetic suppressions may have been falsely overgeneralized, when phonetically 'difficult' segments such as [Θ] are being encountered, or when segments are sufficiently diverse and examples of them in the model sufficiently infrequent to make the appropriate feature generalizations less than obvious -- interference from phonetics has precisely the opposite effect: namely, certain phonological distinctions which have been acquired may be inobvious with respect to certain segments because there is no phonetic distinction by means of which the child is able to show us that he does in fact control the relevant phonological distinction. A very good example of this situation is the status of the fricative consonants in the speech of two of the children discussed in the paper "The Two-Year-Old Stage . . ."

Mackie and Erica had acquired all of the relevant features for the complete set of English fricatives, as evidenced by the operation of those features in other parts of their systems. Their treatment of those fricatives which they partially or completely lacked (phonetically), in terms of the patterns of substitutions and omissions which we observe for those segments, indicates that their phonological systems have 'slots' reserved for these segments. To give one example, Erica correctly pronounces [ð] when it occurs in an extremely limiting environment -- immediately after a segment marked [+nasal]: in all other environments, [ð] is either omitted entirely or [d] substitutes for it -- these two possibilities each occurring approximately 50% of the time. As this pattern is quite different from that of any of her other segments, we can conclude that she has acquired a /ð/ which is distinctive from those other segments; phonetic interference prevents the consistent phonological evidence of her learning. In the limiting case, we can imagine a situation in which a relevant piece of phonological learning is completely obscured in production data by even more substantial phonetic interference.

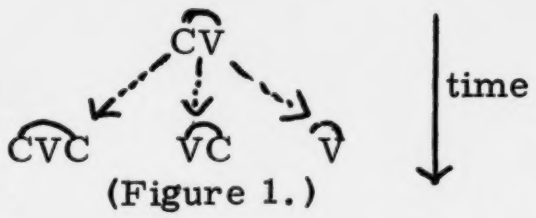
The data on acquisition of fricatives present in the corpora from Erica and Mackie, together with data from a half dozen other children at various ages, indicates that of the four pairs f:v, s:z, š:ž, and θ:ð, the voiceless consonant is acquired before the corresponding voiced on each of the first three pairs, while ð is acquired before θ. In addition, the evidence we have for these four pairs indicates that the second member is acquired quite differently for each. The entire matter of marking has not been investigated sufficiently for a conclusion any stronger than: markedness may be a factor of this strange situation. Markedness is even more obviously involved in phonology learning when we realize that some features are quite skewed in terms of the child's control of them, as specifically exemplified in the child's

considerably later control of [+cont] than [-cont]. The theory of marking may, in fact, benefit considerably from the evidence offered by sound acquisition data, and vice-versa.

VI. The Acquisition of Syllable Structure. The first elementary unit of a child's speech is the syllable, and early words are encoded systematically in terms of the component syllables. The centrality and importance of the syllable in the process of acquisition are due not to its brief tenure as the elementary unit but to the wealth of linguistic concepts which are deduced from its functioning and to its developmental position as the source of other elementary units.

6.1.1. Simple Syllables. The child's earliest syllables correspond to CV syllables of the adult language. (To refer to the child's undifferentiated syllables -- those which are not yet analyzed into smaller components -- we will temporarily mark such syllables with a bow, ⌒, e.g., $\overset{\frown}{CV}$. The problem of notation will be discussed later.) From this $\overset{\frown}{CV}$ syllable grow all of the other syllable types which the child will eventually acquire. Beyond the primary acquisition of the $\overset{\frown}{CV}$, there is no unique and specific pattern, or order of acquisition of syllable types, which could reasonably be predicted as that which all children will follow. The other three simple syllable types (those involving neither consonant clusters nor complex vowels), which will be referred to collectively as 'secondary syllables,' all follow $\overset{\frown}{CV}$ in acquisition, but there is as yet not adequate evidence from other areas of linguistic theory for predicting a relative ordering among them. (It is hoped that future acoustic and articulatory research may produce

appropriate evidence, just as past research has substantiated the primacy of $\overset{\frown}{CV}$.) Thus we can picture an acquisition sequence such as



(Figure 1.)

where the dots indicate unknown and not necessarily equal spans.

More thorough data on phonology acquisition may support the possibility that the ordering $\overset{\frown}{CVC} > \overset{\frown}{VC} > \overset{\frown}{V}$ is statistically the most prominent pattern across a large sample of children in different language environments, but is doubtful that this is a universal. This highly tentative ordering is quite interesting, however, in that it implies the increasing difficulty in a series which seems superficially to involve decreasing complexity. One bit of reasonably favorable evidence is the vocabulary of Hildegard Leopold at age 2, in which $\overset{\frown}{CV}$ and $\overset{\frown}{CVC}$ predominate, both in bound and free positions; there are a few examples of $\overset{\frown}{V}$ in bound position, and no examples of VC as yet.[8] (A complete breakdown of words by syllable structure is given in Table 1.)

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8. The use of bow notation here does not imply that Hildegard has not yet reanalyzed any of her words into units smaller than the syllable, but rather that the syllable structure of her speech at this time obviously still retains the forms imposed by the syllable-learning of earlier steps. We can characterize her speech at age 2 as being typical of one of the several major learning types, specifically that type in which the expansion of syllable structure is rather slow while phonetic and (non-syllabic) phonological experimentation take place liberally within the frames which are early adopted for word structure. Thus it is true for much of Hildegard's lexicon to age 2 that during the time span in which any particular word is used, its phonetic, and even phonemic-segmental, realizations may vary considerably, but its syllable structure is almost always an unchanging one.

One-syllable words		Miscellaneous
CV 33/CVV 24		VCVCVV 1
CVC 50/CVVC 15		Others 3 [include only CV and CVC syllables]

Two-syllable words		
CVCV (redup. CV) 14	CVCV (3 phonemes) 6	CVCV (4 phonemes) 18
CVCVV and CVVCV 11	CVVCVV (redup. CVV) 2	
CVVV 5	VVCV 1	
CVCVC 3	CVCVVC 1	
CVCCVC 2		

Table 1.
Hildegard, age 2.
[VV indicates diphthong]

Partially contradictory evidence is presented by Velten's study of his daughter Joan. (In at least one respect, which will be discussed subsequently, Joan seems to be a linguistically unusual child; whether her early syllable structure is also atypical is obviously an open question. Since Velten's is the only published study of an English-speaking child which includes complete data in a developmental sequence, it is impossible to ignore at this early stage of knowledge.) Joan's first words, at 11 months, were ba and ap, indicating an immediate equality of CV and VC. (As Velten's notation is 'phonemic' throughout, it is possible that [ʔ] initiated ap and subsequent words which seemingly have vowel onsets, in which case this data is not nearly so difficult to handle.) In the next few months, Joan acquires CVC, and Velten notes that at 21 months her preference transfers from syllables of the CV type to those of CVC (obviously, there is a switch in statistical preference, but it is easy to infer from his wording that he senses also a psychological preference). Between 18 and 20 months she acquires V. The complete data are given in Table 2.

Months	
11	ba, ap
12	za, bas, baza (>baza)
13	da, at, bat, ba·ba
14	af (>faf), bada (<baza)
15	ba·, bus, uf
16	dat, bap
17	[illegible]
18-20	da·, as, u·, a, nas, na·na
21	wa·, ats, dudu, hwut (hw='strongly aspirated w')

Table 2: Joan

The lack of evidence for a more explicit ordering of the acquisition of $\overset{\frown}{CVC}$, $\overset{\frown}{VC}$, and $\hat{V}$ from the theory and research in other areas of phonology and phonetics may not be easily remediable, and for now it exists side-by-side with a parallel lack in distinctive feature theory: even Jakobson's detailed predictions about the acquisition of distinctive features (in Fundamentals, Chap. 4) must be tree-diagrammed in a way which does not require explicit time orderings for many of the comparisons involved, despite the fact that there is far more evidence on the behavior of distinctive features than on that of syllables. Research is now called for in free speech, imitation, and perception situations with children at the early stages of acquisition in order to determine whether there actually is a normal (or normative) ordering among $\overset{\frown}{CVC}$, $\overset{\frown}{VC}$, and $\hat{V}$.

6.1.2. The CVCV Word. An interesting fact of phonology acquisition is the frequently noted and previously unexplained reduplication which occurs in the phonological structure of children's early words. Although it is almost indisputable that reduplication is sufficiently rampant that it must be significant

a brief return to Table 1 emphasizes the point. Out of 51 words of the form CV* CV* (where V* = V or VV), 16 -- more than 31% -- are

reduplications. Since Hildegard has 33 CV words and 24 CVV words, a random juxtaposing of any two CV* syllables would produce 57^2 possible CV* CV* words, of which 57 -- less than 2% -- would be reduplications. By any statistical measure of significance, the presence of 31% reduplication is a purposeful and important phonological device.[9]

The phonological process which allows the child to reduplicate syllables (and, in fact, pretty much demands that he do so) has an extremely simple explanation. Once the child has encoded a small syllabary (most or all of which is not yet further analyzed), he faces the need to produce words longer than CV; by now the concept of 'word' is strongly entrenched in his linguistic cognizance and he has begun or is beginning to recognize that words are often longer than one syllable. Absolutely the simplest manner in which he can produce a longer word is to utilize one unit -- a single CV -- twice, and the result is reduplication, a phonological phenomenon which embodies several significant precursors to the adult phonological structure. First, where the child previously had only an equation

(1) $$W=S$$

(where W stands for 'word' and S for 'syllable') which involved no directionality, he now has a rule

(2) $$W \rightarrow \begin{Bmatrix} S \\ S_i + S_i \end{Bmatrix}$$

and, in particular, one which involves directionality; no longer is he confined to simply filling in a word slot with a single unit from his syllabary: he is now able to generate items to fill the word slot by imposing a structure, namely, reduplication, on any of those elementary

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9 If we look only at CV syllables where the vowel is simple, we would expect 33^2 possibilities, of which 3% would be reduplications if random; in actuality, we find 37% reduplicated words among the CVCV types, and an additional 15% 'partial reduplications.'

units of his inventory. We have no way of knowing that at the earlier stage he did not, in fact, have the rule

(3) W→S

rather than the equation given above. There does not seem to be any way to test the psychological difference between the two. Purely in terms of linguistic description, there is no reason to infer structure where it is not needed, and where that might be tantamount to imputing structure where it does not exist. The first combination of two elementary units into a word presents an adequate behavioral criterion that the undifferentiated syllable and the word are no longer identical concepts, and therefore forms the first linguistic evidence that rule (3) is a better description than equation (1); rule (3) is incorporated as part of rule (2), the entirety of which succeeds and replaces equation (1). The emergence of the first reduplicated word then reveals the acquisition of the basic ideas of linguistic rule, of the directionality which a rule involves, and of the formal separation of the phonological inventory (syllabary) from the word list (lexicon).

The second significant precursor which is embodied in this monumental achievement of the initial reduplicated word is the recognition by the child that there is a formal phonotactics which governs the construction of words. (In an even larger sense, this could be viewed as a recognition of syntax in general, although the syntax of word combination, as opposed to word formation, cannot be behaviorally displayed until later. Such a view, however, is not really testable.) This phonotactics is extremely limited, allowing only the occurrence of either a single elementary unit or of two identical elementary units; but even such a rudimentary phonotactics as rule (2) already incorporates a generalization which will remain true throughout the entire development of phonology, namely that the more elementary units there are in a string which comprises a word, the more restrictions there are on those elementary units: note that the second part of

rule (2) requires indices while the first part does not. (It is of course not true that there is one-to-one correspondence in the adult phonology between the length of a word and the total number of restrictions relevant for the selection of the elementary units which comprise it, but the relationship does hold as a generalization: i.e., if we plotted word length against total number of restrictions over the entire adult lexicon, and then smoothed the curve out a bit, we would expect the result to be an increasing function (one which has no decreasing slopes).) We note that the phonotactics operates at the level of elementary units but does not reveal any information about the units themselves. At this stage, the internal composition of the syllable is a phonetic, not phonological, matter; when the child begins to recognize other elementary units, such as segments and distinctive features, he will immediately formulate phonotactic rules governing their combinational possibilities within words, and at that point the internal composition of the syllable will become phonologically relevant and interesting.

At least one more significant precursor is inherent at this point in development -- that of phonetic invariance -- although for some children it may have occurred even earlier, as evidenced by the near-identity of the phonetic composition of different tokens (across time) of some words. For those learners, however, who displayed disparate phonetic representations of the same words, the advent of words involving reduplication may be the first occasion which necessitates a consistency in the phonetic production of the same syllable, at least across the time span required for the two-syllable word -- although subsequent productions of that word, each being internally consistent, may still be different from each other.

After the landmark of reduplicated-syllable words has been achieved, the next step is the production of a $\overset{\frown}{CV}\overset{\frown}{CV}$ word which, in terms of adult phonology, consists of only 3 different segments; i.e., either the onsets or the vocalic portions of the syllables are identical.

These partial reduplications seem to be an intermediate stage, followed naturally by the $\widehat{CVCV}$ word composed of four unlike segments. Some of the $\widehat{CVCV}$ words of this final complexity may still be encoded and stored in syllabic form, but many will consist only of those most basic segments which have by now been reanalyzed and re-encoded as segments through their more extensive utilization in the syllabary. Thus this final stage no longer belongs strictly to the developmentall sequence of syllable acquisition. The stage of partial reduplication, however, is extremely interesting, primarily because it falls into what is currently -- through lack of data -- the very hazy area of transition from syllables to segments and distinctive features. When the child is beginning to formulate words of the patterns $\widehat{C_iVC_iV}$ and $\widehat{CV_iCV_i}$, he is very likely still operating primarily within the framework of his syllabary, utilizing primarily units which are therefore already existent. It is the interaction between phonetic fact and phonological rule which is here most interesting: does the child's mental comparisons of the units in his syllabary resulting in a partial reanalysis of some items into component segments, allow him to recombine them more randomly than was permitted before, now based on the new rules which his deductions have added to his phonotactics? Or is quite the opposite the explanation -- that the child's phonetic capacity is outstripping his phonological one, and, although words still occur in the phonological form $\widehat{CVCV}$, the phonetic practise which has been an inherent by-product of phonological reduplication has resulted in a more sophisticated concept of identity which permits a partial phonetic identity (e.g., same onsets) to qualify two still-unanalyzed-phonologically syllables as elementary units in what is still phonologically a syllable-reduplication word pattern ?[10] There is no evidence at all which bears

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10 Notice that this second possibility implies that the phonetic -- both productive and perceptive -- abilities of the child are very acute, and he has a very sophisticated ability to make three-way judgments of same: partially same (partially different): different.

on the point. (In fact, as will be seen shortly, in the unusual case where a diary writer even noticed this phenomenon, he failed to realize the significance or to draw any appropriate conclusions.)

In terms of other things we do know about with regard to phonology acquisition, the second explanation seems more plausible. It seems that for every patterned step of the process we have discussed so far, there is a linguistically logical motivation, and each step has contributed to the complex set of concepts which underlies the organization of phonology. The first explanation offers a deviation from this pattern: it assumes a complex mental process, the linguistic necessity of which is not apparent, which is then implemented in a rather limited way phonetically. (Why wouldn't this phonological reanalysis result directly in a word with four different segments?) In a later section we will examine some scattered evidence that phonetic ability (with a few exceptions) is at all stages more advanced than phonological production, and is obscured by that production so that it seems to be more limited than it actually is. Assuming this to be true, the second explanation -- that phonetic advances cause changes in the phonology -- is more plausible in terms of patterned, motivated progress, and provides adequate justification for the existence of partially reduplicated words as an intermediate stage.

Although the data quoted in Burling's diary article do not, unfortunately, comprise a complete lexicon, together with Burling's comments they are sufficient to allow a very nice picture of the development of the $\overset{\frown}{CV}\overset{\frown}{CV}$ word. At 1.4, the child has 'twelve or so' words, all of them $\overset{\frown}{CV}$ or reduplicated $\overset{\frown}{CV}\overset{\frown}{CV}$ types (e.g., ma, kiki, tu). At 1.5, he 'learned *suddenly and decisively** to use two different syllables in the same word, including either different vowels or different consonants,' as exemplified by kiti (<kiki) and babi. Within the theory of phonology with which Burling was working, this development at 1.5 revealed no increase in the child's knowledge whatsoever: the lexicon at 1.4 evi-

*italics added.

denced that the child 'knew' the 'phonemes' /ptkmnaiu/, and this decisive step on Stephen's part at 1.5 involved no new phonemes. (Precisely that it did not utilize new phonemes is significant for the thesis of this paper.) Realizing the philosophy of phonemic theory in which this case history presents the data, the quotation above is unusual; in fact, it does not fit the tone of the rest of the paper at all. We can only conclude that something about Stephen's behavior must have been extremely striking in order to motivate the father's observation. Could it be that Stephen was quite pleased with himself for what he recognized as a significant breakthrough? Near the end of the month, Burling tells us, his son 'acquired' the phoneme /l/; he used it for the name of his Garo nurse, Emula. He produced it as lala, a fact which Burling does not question. Since the article basically discusses the order of acquisition of taxonomic phonemes, we have the right to wonder why Stephen did not pronounce this name as mula: he already had 'acquired' the phonemes /m/, /u/, and /a/. The answer is that he was not acquiring /l/, but rather the syllable $\overset{\frown}{\text{la}}$. At this very early stage of verbal behavior, this radically new syllable had to be utilized in the earlier practise frame of the reduplicated $\overset{\frown}{\text{CV}}\overset{\frown}{\text{CV}}$ word, a frame whose function (partially) is to provide ideal conditions for the stabilization of the phonetic realization of the new syllable by time-wise juxtaposing two occurrences for the sake of comparison. To have chosen instead the pronunciation $\overset{\frown}{\text{lu}}\overset{\frown}{\text{la}}$ would have been to choose a structure at the very limits of his phonological capacity, introducing a conflict with the need for phonetic practice: perhaps the child at 1.5 is sensible enough to attack only one 'linguistic front' at a time with each new word. The pronunciation $\overset{\frown}{\text{mu}}\overset{\frown}{\text{la}}$ is obviously far beyond the child's capabilities at this point. The word $\overset{\frown}{\text{la}}\overset{\frown}{\text{la}}$ is for Stephen a by-product of an extremely adaptive mechanism which balances the phonological and phonetic complexities in such an intricate way that a new lexical item makes only a limited contribution to the advancement of the sound system and

also makes only limited demands on the expanding productive capacity: the child cannot utilize just one lexical item as a source of considerable achievement both phonologically and phonetically.

Since syllables are not learned in isolation, but along with many other aspects of the sound system, the actual data rarely look quite so neat as those offered by Burling. (The neatness there is an example of the artificiality which is imposed on data of this type when it is presented in terms of one basic unit which is assumed to remain at the base of phonology throughout the learner's life: some phonetic detail is omitted because it has been analyzed out as 'allophonic' -- a good example of the way in which significant aspects of the development of the sound system can be obscured by the obsessive desire for an analysis which utilizes the same criteria as would an analysis of an adult sound system -- and some phonetic detail is overanalyzed and labeled 'phonemic' despite the fact that for the child it is a phonetic manifestation but not yet an independent part of functional phonology.) Therefore the data of Table 3, which are given in more complete detail and therefore present a picture of many things which are occurring simultaneously, is far less neat. The progression of structure within the two-syllable word in Hildegard's early speech nevertheless conforms quite well to the pattern which has been outlined in this section. The earliest words are $\overset{\frown}{CV}$, and the reduplicated form appears soon after; up to 1.4, words of these forms are the greatly dominant part of her vocabulary. The first multi-syllabic word is aberant in that it consists of three rather than two identical syllables; that this is a phonetic experiment, and not a phonological possibility, is evidenced by the subsequent stability of bi-syllabic reduplicated forms. Just before the end of her first year, actually earlier than we would normally expect it, the first partial reduplication appears. That t'i-t'a is not instead a conforming simple reduplication, may be related to the complex psychological factors involved in the motivations which deter-

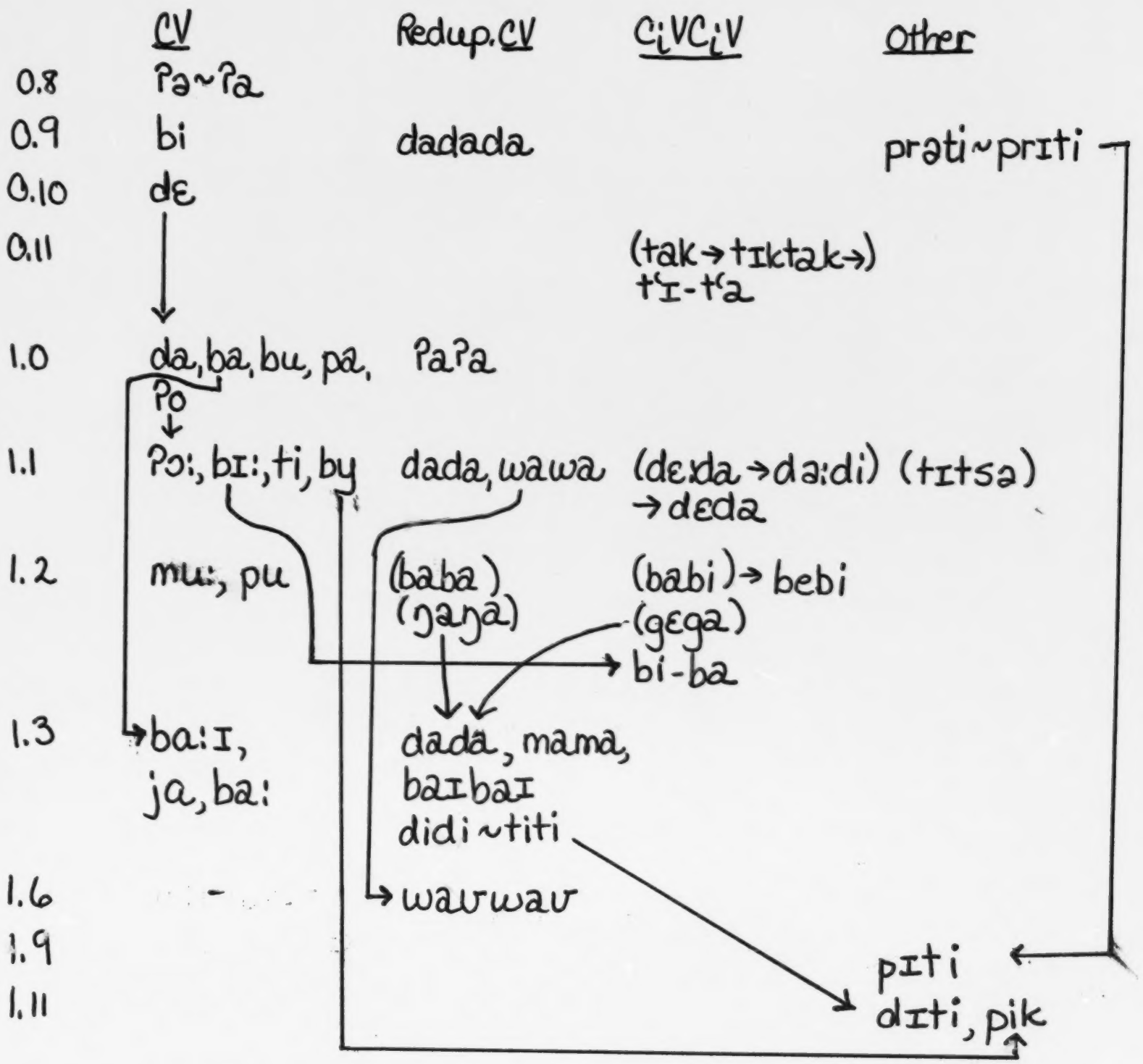

Table 3. Hildegard's vocabulary to age 1.3, with changes which words later underwent. Forms in parentheses occurred only once or twice.

mine what particular lexical items the child chooses to add to his vocabulary (Interestingly, Leopold transcribes this word with a hyphen separating the syllables. Although he never explains what he means by the notation, we might assume that some kind of pause occurs between the syllables, indicating that the word is not $\widehat{CVCV}$ at all but is instead a concatenation of two separate syllables. The same notation is also used for the partial reduplication bi-ba which occurs at 1.2: that this is the only multi-syllabic word on the chart which is a lexical descendant of a uni-syllabic form may be supportive evidence of this hypothesis about the meaning of the notation.) From Leopold's notes we find that Hildegard was extremely fascinated by clocks and devoted a good deal of her time and attention to them, and so perhaps she is highly motivated to match as accurately as possible the phonetic sound of the label which her father offered -- 'tick-tock' -- which, incidentally, may have been an additionally appealing word because of its onomatopoetic value. Her first attempt at the word was tak (hypothesis: $\widehat{CVC}$ must precede $\widehat{CVC}\widehat{CVC}$ just as $\widehat{CV} > \widehat{CV}\widehat{CV}$), and her second rendition was tiktak, a phonetically accurate and phonologically impressive achievement, but one which could not be maintained. The word became stabilized as tɪ-ta, a sort of compromise between the more elaborate possibilities offered by her phonetic ability and the more restrictive demands of her phonological system.

If we ignore for the moment the fourth column of Table 3, we can follow the developments shown in the table, then, as being highly supportive of the theory under discussion. Of incidental interest is the kind of experimentation which Hildegard permits herself to pursue within the narrow confines of her phonology. In the same spirit as the sequence leading to the stabilization of tɪ-ta, we observe the compromises which reduce the complexities of dɛda and dada (< gɛga); the first of these evidences the limitation of phonetic long vowels, an experimentation which is immediately pushed back to the level of the $\widehat{CV}$ syllable,

where it is nurtured and leads further to the advent of the dipthong, in which form it later returns to the multi-syllable word (a reduplicated one, of course, parallel to Stephen Burling's lala). A different type of change of a lexical item occurs over a longer time span: what is for a while a perfectly stable word is later changed to another, related, stable form, one which reflects a more advanced phonological stage. Because such words did not have to be changed, they indicate the stability and mastery of their new phonological representations (as opposed to the first occurrence of those representations which, like tɪ-ta, may be compromises which indicate the absolute extreme limits of phonological possibility and are the precursors of new forms rather than the manifestations of them). Examples of this situation are ba>ba:ɪ at 1.3, which indicates the solid status of long vowels in CV; wawa wauwau at 1.6, dipthongs; didi~titi>dɪti at 1.11, the four segment CVCV; and by>pik at 1.11, the CVC syllable.

Now that we have tacitly returned to column 4, we must deal with the one glaring exception it presents, the extreme deviation from an otherwise completely explainable pattern. The existence of prɪti in the lexicon is not a counter-example to the theory, is simply is a glaring exception; it is a very nice example of what Jakobson meant when he said that there are often some extra-systematic phenomena in children's speech. In contrast to the examples in Hildegard's lexicon where the limitations of the phonology held back the exuberancies of a phonetic capacity far more elaborate than we can ever know, this one word utilizes that capacity to as great an extent as possible. It remains outside of the system in a very real sense; not only does it avoid conforming to the constraints of the phonological system, but also its deviance exempts it from benefiting as a result of subsequent refinements and advances of the phonological system.

As an isolated, memorized item, its encoding is incommensurable with that of any other part of the system; in particular, as long as it

continues to remain outside of the system, it is nothing more than a phonetic entity and it cannot incorporate additional appropriate phonetic complexities as the phonological system makes such complexities available to the other lexical items. Exactly what the encoding of this item could be -- as a single word-unit or as two syllables -- is neither knowable nor important. What is important is that it is a representative of a phenomenon which occurs more frequently in children's vocabularies than we recognize, primarily because most of the other examples do not happen to be so glaringly different from the rest of the lexicon and can be either described within the system itself, or within a slight modification which is a distortion of the child's actual grammar, but a distortion sufficiently minor that we cannot recognize it as such. In the case of Hildegard's 'pretty,' it would be too obvious to be ignored: she has no other consonant clusters, and even no other examples of either p or r in any other syllables. After a long tenure, the isolated prīti gives way to pīti, which seems superficially to be simpler but is actually far more complex, precisely because this new item is a concession to the system and is governed by the same restrictions on phonetics which operate throughout the lexicon, and is generatable by the same phonological rules which operate everywhere else. Words of this deviant type do not always get re-encoded so efficiently and so early; many of those which remain in their phonetic encoding, particularly when their form is much simplified from the adult model, show up as 'residue words' when their production does not improve correspondant to other lexical items when the advancing phonological system would allow a more complex representation. (There are other sources of extra-systematicity which also result in 'residue words,' such as the failure to re-encode an item from one organizational level to another -- e.g., from syllables to segments -- so that the item remains in a form to which the revised rules of the phonology are inapplicable.

6.13. Complex syllables. We have just seen the vast implications of two of the simplest processes that mark the early syllabic stage of sound acquisition, namely that stage which immediately follows the initial acquisition of the $\widehat{CV}$ word. To briefly review, we hypothesized the acquisition order

$$\widehat{CV} > \widehat{CVC} > \widehat{VC} > \widehat{V}$$

as the one which may turn out to be the most prominent of the patterns which a large number of case studies evidence. It would be foolish for us to attempt to predict a universal ordering among these simple syllables, for they are, when first introduced into the child's production, the elementary units of his speech: they are phonologically undifferentiated with respect to what will later be reanalyzed as their component parts. Thus the individual differences between these forms are phonetic ones, and we follow an accepted tradition of linguistics in precluding phonetic material from the domain of universal statements. The ordering substantiates, however, much that is known about the phonetics of syllable structure in its obvious preference for consonantal onset over offset, as well as the distinct preference for a consonantal environment for the vowel. Further investigation of this early ordering may lead to significant findings in the field of articulatory phonetics. At least one result is already obvious, despite the cursory nature of the data supporting the hypothesis: that $\widehat{CV}$, which we have called 'primary,' is antecedent to the other three, which we have called 'secondary,' and thus the phonological universal which predicts the occurrence of $\widehat{CV}$ syllables in all languages is based on a phonetic necessity. In addition, we hypothesized that the development of the $\widehat{CV}\widehat{CV}$ word composed of four distinct segments is predicated on the necessary introduction of reduplicated words into the lexicon, and is mediated by a stage of partial reduplication. As necessary results of this process we find the development of a concept of rule, and more particularly, rule involving directionality; the precursor form of

phonotactics, and strong evidence for an awareness of the role of phonetic identity within phonologically-manipulatable situations. The child's initial awareness of the function of phonetic identity in phonology will eventually lead him to the recognition of the profound function of phonetic dissimilarity.) Despite the substantial limitations on both communication ability and linguistic knowledge, the child has at this point made such significant discoveries that we could almost say that the rest is just a matter of filling in the multitudinous details.

The learning of complex syllables, those utilizing long vowels, diphthongs, and consonant clusters, is no longer a purely phonetic matter. Although such learning takes place as the acquisition of syllables which enter the syllabary and are subsequently (or, later, simultaneously) reanalyzed, there may be a certain amount of interference due to prior reanalysis of the component parts from their functioning within simple syllables; but this interference is minimal due to the phonetic dissimilarity of segments in distinct environments.

Complex syllables can then be said to be learned in precisely the same way simple syllables are learned (as a slight oversimplification). The child's phonetic capacities have not increased at this stage:- they have possibly even decreased slightly, due to the phonotactic learning which has been concurrent with the phonetic practice of simple syllables -- but his constant awareness of the deficiencies of his system in comparison with that of the adults surrounding him, together with his increasing mastery of that which he has previously attempted, leads him to attempt to incorporate phonetically more complex units and combinations thereof into his phonological system. This step is not inherent evidence of an increase in the child's capacity; it indicates, instead, his feeling of comfort in the progress he has been making, and it will result in a greater need for his reanalyzing and re-encoding his elementary units if he has not already begun to do so. It is much more a practice than a learning stage, and we would

expect to see, at least for the simpler and earlier-acquired complex syllables, considerable practice with their phonetic possibilities.

Complex syllables, of course, develop from all four simple syllable types. (Notice that this implies that there is the potential for some limited number of $\widehat{CV}$ syllables to develop rather late as complex syllables formed on the base of the early $\widehat{V}$ form, as well as the more expected possibility that some $\widehat{CVC}$ syllables will be complex ones growing out of $\widehat{CV}$). We would naturally expect the primary syllable, $\widehat{CV}$, to be the most significant source of complex syllables, because of its primacy (which has produced greater opportunity for its use in phonetic practise) and because it limits the additional details which must be attended to when either the consonantal or vocalic aspect of it undergoes complication, details which are inherent in other forms -- i.e., the presence of a final -C in $\widehat{CVC}$, the absence of an initial C- in $\widehat{VC}$.

It has frequently been noticed that English-speaking children learn the complexities of the English vowel system quite early, although the 'proper' use of these complexities may take a good deal of time to stabilize, and English-speaking children may go through quite a long period in which all of the diphthongs are known and used but individual lexical items occur with incorrect ones, and may vary considerably from day to day.

Since intonation is one of the earliest aspects of human speech which the child notices and learns to control (more will be added to this point in section 6.2), we could reasonably assume that the child continues to pay attention to stress and pitch patterns as potential cues for his own future discoveries of significant aspects of speech. Indeed, the ability of a fairly sophisticated two-year-old child to perceive and accurately reproduce intonation patterns (see Moskowitz, 'A Sample Study with the Pitch Extractor,' and Moskowitz, 'Imitation of Duration," MIM Nov. 1969) indicates that long after the child has

completed the major part of phonological learning he still pays considerable attention to the information he receives from the fundamental frequency of another speaker's voice. Since such information is carried almost exclusively by the vowels in English, we would naturally expect the child to focus his attention on the complexities of the vowel system quite early. He bears witness to this focus in his early experimentation with the vocalic part of the $\widehat{CV}$ syllable. The vocalically-complex $\widehat{CV}$ is probably the earliest complex syllable (Hildegard, for example, has extensive evidence of this $\widehat{CV}$ in her syllabary, but no other complex syllable whatsoever), and it may, in fact, develop in a parallel fashion to the simple $\widehat{CV}$, first participating in reduplicated forms and eventually achieving the autonomy of the maximally different $\widehat{CV}\widehat{CV}$ word, where either vowel may be simple or complex. The complex vowel of the $\widehat{CV}$ occurs initially as a long vowel (we see evid ence of this both in Hildegard's speech, Table 3, and Joan's, Table 2), possibly for reasons of pho netic constraint. From this long vowel develops the diphthong, at least conceptually: phonetic development of diphthongs in individual lexical items may result directly from the use of the original short vowel as the onset of the new diphthong. Thus we see in Hildegard's speech the earliest occurrences of long vowels at 1.1, when ʔo is replaced by ʔɔ:; the briefly-tried dɛ: of dɛ:da was preceded by the item dɛ three months earlier; and bɪ: was preceeded by bi by four months. The first diphthong, in bɑ:ɪ, significantly reveals its conceptual roots in the retention of the long vowel; bɑ:ɪ replaces ba at a time when a totally separate lexical item, ba:, is introduced, and we have the feeling that the slight change in vowel quality, together with the diphthongization, are attempts at maximal differentiation. During the same month the reduplicated form baɪ baɪ appears, and three months later waʊwaʊ replaces wawa. By the time Hildegard reaches two years of age, the intricacies of her diphthongal system are of sufficient number and impressive enough

scope to convince us that the expansion of the $\widehat{CV}$ as a complex syllable of this type has occupied a good deal of her linguistic effort. An analysis of her system at that stage which assumes the independence of the two elements of the diphthong (see Moskowitz, 'The Two-Year-Old Stage . . .') leaves us with the feeling of contrivance; but an analysis which assumes instead the distinctive and contrastive segmental function of these diphthongs leaves us less satisfied still, for many of these diphthongs have no model in the adult phonology. The most satisfactory analysis would have to be based on the assumption that the vast majority of these diphthongs are non-segmentable parts of complex $\widehat{CV}$ syllables which remain so encoded in the syllabary, while a few -- and in particular those few which occur in several words -- have been re-encoded as segmental units, contrasting with the several simple vowels which have probably already been re-encoded also.

An additional form of complexity which can develop from the $\widehat{CV}$ syllable is the multiplication of initial consonants -- the formation of $\widehat{CCV}$ syllables. As an aspect of production, the $\widehat{CCV}$ syllable occurs rather late (although, obviously, earlier than a syllable with a final consonant cluster), and the notational issue of whether we should represent it as $\widehat{CCV}$ or $C\widehat{CV}$ or CCV is a very important one. It may well be that for different children, for different consonant clusters, and even for different languages the answer will be different. That the $\widehat{CCV}$ syllable is perceived early, as distinct from the $\widehat{CV}$ syllable, is unquestionable. But not all CCV syllables of the adult model are treated equally in the child's reproductions. Among the earliest initial clusters we see in a child's speech are those which typically consist of stop+liquid, and we can have no doubt that such a cluster is somehow phonetically simpler to produce. A child's word such as grϵ is still encoded syllabically, although it is not clear whether the syllable form is $\widehat{CV}$ or $\widehat{CCV}$. (To offer an alternative encoding CLV, where L stands for 'liquid,' is an unsatisfactory way of substituting

notation for a more adequate insight into the nature of the child's knowledge.) We must take into account the fact that this cluster type often occurs extremely early, often even before a liquid occurs without a preceding consonant. In a very real sense, this prototype consonant cluster is actually functioning as a single consonant for the child, and the lines which distinguish it from $\overset{\frown}{CV}$ are hazy: gr- may be a consonantal onset for a syllable quite on a par with g. Because such clusters do enter the inventory considerably later than the initial stop consonants, we would want to predict that they are re-encoded fairly soon after their initial occurrence, indicating a fairly immediate switch to the $\overset{\frown}{CCV}$ analysis.

Another fact which complicates the issue of the notation for such initial clusters is one which has been noticed by several independent investigators, namely, that before the English-learning child correctly produces an initial s+ stop cluster, he substitutes an appropriate unaspirated stop for this cluster. Moskowitz ("The Two-Year-Old Stage ...") noticed that this substitution consistently involved an unaspirated stop even though the presence of aspiration was still a limitedly free variation of the phonetic production of stops in all other environments. (Additional implications of this fact will be discussed subsequently.) The unaspirated onset of such syllables is without doubt phonetically only one consonant, but considering the phonological contrast that is maintained between those initial stops without aspiration and those for which aspiration is a freely variant feature, is it more reasonable to classify such syllables as $\overset{\frown}{CCV}$ (thus tacitly recognizing the function which absence of aspiration serves for the child while ignoring the phonetic 'reality'), or as $\overset{\frown}{CV}$ (thus recognizing the phonetic contrast which the child is able to maintain but not acknowledge its systematic function)? The latter solution requires that we formally note by a change in notation the acquisition of clusters of the type s+ stop as a part of the child's productive phonology only when he has mastered

the complete phonetic representation of it; the former solution takes such phonological note at the point when the child can first control some phonetic distinction to indicate his knowledge, and relegates the noting of the improvement of phonetic detail to the theory of acquisition of phonetics. Thus we can see that the problem involved in the notation CCV is one which indicates a larger area of concern, namely the conflict between phonetics and phonology. We must then choose the notation $\overset{\frown}{CCV}$, which is less commital than $C\overset{\frown}{CV}$ or CCV; it is somewhat arbitrary in that it no longer indicates the child's lack of more detailed analysis of component parts, but rather indicates the immense integrity of this syllable form in the child's production.

Considerably more research is needed in the area of initial clusters before any more definite conclusion can be drawn.

6.1.4. Other Multi-Syllabic Word Forms. In addition to the $\overset{\frown}{CV}\overset{\frown}{CV}$ word, other multi-syllabic words develop eventually in the lexicon. Lack of relevant data precludes all but the most tentative hypotheses about these processes. Several such hypotheses seem to develop naturally out of the material examined so far.

(1) Bi-syllabic words are first produced by the combination of two simple syllables. Unlike the situation with the development of CVCV words through reduplication of the primary syllable, we would not expect to find either reduplication or even simple concatenation of the secondary syllables. There no longer is need for reduplication, as its purposes have already been served. Simple concatenation would result in the forms $\overset{\frown}{CVC}\overset{\frown}{CVC}$, $\overset{\frown}{VC}\overset{\frown}{VC}$, and $\overset{\frown}{VV}$, all of which are phonetically unmotivated in some measure; $\overset{\frown}{CVC}\overset{\frown}{CVC}$ is probably the only one of these which will appear reasonably early. (Hildegard has one example of this form, tusbos, in her speech at age 2.) We can expect to see earlier concatenation of two different syllable forms, probably the most frequent being $\overset{\frown}{CVC}\overset{\frown}{VC}$.

(2) As complex syllables are introduced, they may be utilized subsequently in bi-syllabic forms. Except for the reduplicated $\widehat{CV}\widehat{CV}$ form which involves a complex vowel, we would not expect to see more than one of the two syllables as having a complexity.

(3) In words of more than two syllables -- which would occur considerably after bi-syllables -- the original forms will ideally contain only $\widehat{CV}$ syllables. Subsequent forms will slowly introduce secondary and complex syllables.

6.1.5. Development of Morpheme Structure Rules. Both segmental and distinctive feature theories of sound acquisition have had little to say about some of the most conspicuously difficult problems of describing a child's sound system. The problems fall into two categories: (1) What are the criteria for learning? I.e., at what point can we make the decision that a particular segment or distinctive feature has been learned? and (2) Since the order in which phonotactic rules are learned varies from child to child, how can we make significant generalizations about such learning? We will take these problems one at a time.

6.1.5.1. The criteria-for-learning problem is one which we have ignored largely because our theory until now has encompassed no way of approaching a solution. Given the raw data which represent the phonetic output of the child, we have no way of discussing the notion of whether the child has learned a particular phoneme X or a particular distinctive feature Y. Within psychology, we find the phrase 'learned to criterion' used frequently: a behavioral goal is selected as the criterion which the subject must achieve in order to be considered as having learned the task. Suppose we consider the task of 'learning the phoneme /p/,' and suppose we examine three stages -- at precisely ages 1, 2, and 3 -- and find in the data the following:

(1) At age 1, the child has seven words, one of which contains [p-].

(2) At age 2, the child has a vocabulary of several thousand words: a statistical substitution analysis of a 4-hour corpus reveals that in word-initial position 89% of the expected occurrences of /p/ are correct, 11% are substitutions by other phones, and 0% are omissions; intervocalically, the statistics are 83%, 12%, and 5%; in final position, they are 64%, 5%, and 31%. Most of the words which occur more than twice in the corpus vary phonetically so that the presence of [p] in one rendition does not imply its presence in another. /p/ occurs sporadically in consonant clusters.

(3) At age 3, the child correctly uses all allophonic variants of /p/ in all appropriate positions; omissions and substitutions are negligible.

Now, in this situation, what criteria could we use? At which of these three stages can we conclude that /p/ has been learned? Likewise, when could we say that the features relevant to /p/ have been learned? What does it mean to say that a segment or a feature is 'learned'? That these are pseudo-questions with little or no meaning is obvious. But the entire theory of phonology acquisition to date, which has been aimed at the discovery of order of acquisition, has ignored precisely that. Within the present theory of syllable acquisition we may set as the criteria for learning the simple demonstration in production -- with the difference that what is considered to have been learned is neither a feature nor a segment, but instead some subset of the functions of these units as determined by the phonotactic rules which the child has deduced from his syllabary. At (1), the child has learned a single syllable which indicates his phonetic ability to produce some allophone of [p] in the $\widehat{CV}$ form. When, at some subsequent time, he will have added enough syllables with onsets considerably like [p], he may deduce that these are phonetically similar enough to constitute different forms of the same segment; at that time he will have a concept of the phonological unit /p/ which can occur initially in $\widehat{CV}$ and which occurs in slightly different guises before different vowels,

the phonetic nature of these guises being determined precisely from the differences he has noticed in the various [p]'s within his syllabary. At (2) he has learned syllable-initial /p/ quite well, although he still experiences some difficulty in controlling its acceptable phonetic reflexes, as reflected by the larger percentage of substitutions than omissions. Syllable-final /p/ has been learned for some syllables but not others; the problem here is not the correct phonetic output -- substitutions are rare -- but is instead the incompleteness of the phonological deduction that some syllables end with /p/. We might view this as an instance of $\overset{\frown}{CVC}$ being reduced to the earlier $\overset{\frown}{CV}$, for which there could be a variety of motivations. At (3) he has learned all of the phonotactic restructions on /p/; he has learned the minor but consistent differences between /p/'s before two different vowels through his experience with different $\overset{\frown}{pV}$ syllables; he has learned the major allophonic differences between /p/'s in different positions within the word through his experience with different elementary syllables; he has learned the phonotactic restrictions on what clusters /p/ can and cannot occur in through his experience with just those complex syllables which contain /p/ -- he knows what the phonetic realization of /p/ will be in these particular contexts and 'knows' that /p/ does not occur in other contexts.

Thus the answers to the criteria-for-learning problem become obvious when we are interested in the more detailed learning the child does -- such as control of the consistency and variability of phonetic detail of phonological concepts and abstractions -- rather than setting for ourselves the absurd task of determing when partiality determines completeness.

6.1.5.2. The significant generalizations which can be made about phonotactic rule acquisition all stem from the process of syllable learning which the child goes through. His earliest learning is relevant to the phonetic restrictions on consonants and vowels as they

are adjacent to each other in simple syllables. His earliest consonant clusters are those which occur medially and are the result of a $\overset{\frown}{CVC}\overset{\frown}{CVC}$ or a $\overset{\frown}{CVC}\overset{\frown}{CV}$ concatenation. More complicated medial clusters will always result from the prior acquisition of initial or final clusters which then can enter into medial clusters through such concatenation of syllables. It is quite significant in this regard that alternations in the order of consonants in a child's production of a word with a consonant cluster occur only if the consonants involved are within one syllable. Thus we may see 'deks' for 'desk,' 'psgetthi' for 'spaghetti,' or 'spadachio' for 'pistachio,' but we would never find '*bat-thub' for 'bath-tub' or '*pitker' for 'picture.' Alternations of this type do not occur across syllable boundaries precisely because each syllable has been learned as a unit by the child at some previous point, and its integrity does not allow the interchange of its constituent parts with those of adjacent syllables. Within a syllable, particularly when new consonant clusters are being introduced into the framework, the problems of time ordering are quite significant for the child, and it would be easy for him to reverse two consonants whose ordering within the syllable has not yet become stable.

Just as Anderson's example for adult phonology implies, certain medial clusters result from simplifications of the concatenation of syllable-final consonant(s) with syllable-initial consonant(s). Regular rules govern the processes of deletion and alternation which consonants undergo in such medially-formed clusters. If an internal geminate consonant resulted, for example, we would expect that one of the two consonants will be deleted -- in terms of developmental priorities, the first would be deleted; for the synchronic description of adult phonology, the choice we make may be different. After the child learns such deletion, he next learns additional phonetic detail, such as the realization [D] for /t/≺/tt/ in 'butter;' although all other

allophonic variants of /t/ may be learned considerably earlier than [D], the implication is not that [D] is phonetically more difficult -- its late occurrence is caused by the intricacy of the phonological prerequisites for it. Many of the phonological processes described in Chapter 5 of The Sound Pattern of English fall into this category, and we must therefore look for the learning of them in these latter stages of complex syllable concatenation. Other rules described there, such as vowel shift, will be evidenced in the stage of learning when multisyllabic words occur in large numbers. In comparison, redundancy rules will be learned through absolute syllable structure, not concatenation.